What Does Good Assessment of Laboratory Skills Look Like?
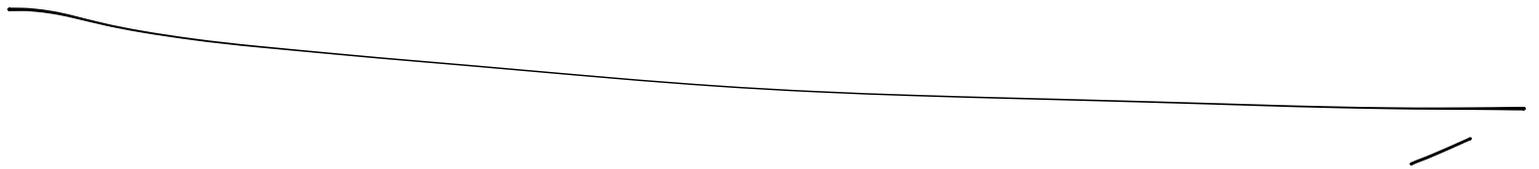
What Does Good Assessment of Laboratory Skills Look Like?

What is Love?

1. an Emotion
2. Shared Bond
3. Desire for Someone else happiness.
4. Base on Respect, Shared interest etc.

How Do You Assess it?

Uses of Assessment

Pre-workshop Assignment

- · Access and assess appropriate scientific literature. Develop hypotheses and propose appropriate experiments to test them.
- · Use data bases and bioinformatics tools.
- · Design and conduct experiments and to record/archive the data appropriately.
- · Use appropriate data analysis and interpret the results of experiments.
- · Present the overall goals and detailed results of experiments in a variety of formats to a variety of audiences.
- · Work safely, both alone and in an effective team.
- · Summarize and convey information orally, visually, and in writing.
- · Recognize and understand the ethical issues involved in both the conduct of research and in the dimensions of research.

A Consensus List of Skills to Guide Assessment

- 3 Broad Conceptual Areas:
  - **Process of Science**
    - Can develop a hypothesis, design and conduct appropriate Experiments
    - Is able to analyze and interprete data using appropriate quantitative modeling and simulation tools
  - **Communication and Comprehension of Science**
    - Can Access, Assess and Use Available Information
    - Is able to present scientific data in an appropriate context and in a variety of ways at different levels
  - **Community of Practice Aspects of Science**
    - Appreciates the opportunities for interdisciplinary collaboration and the ethical dimensions of science
    - Can work safely alone and in an effective team
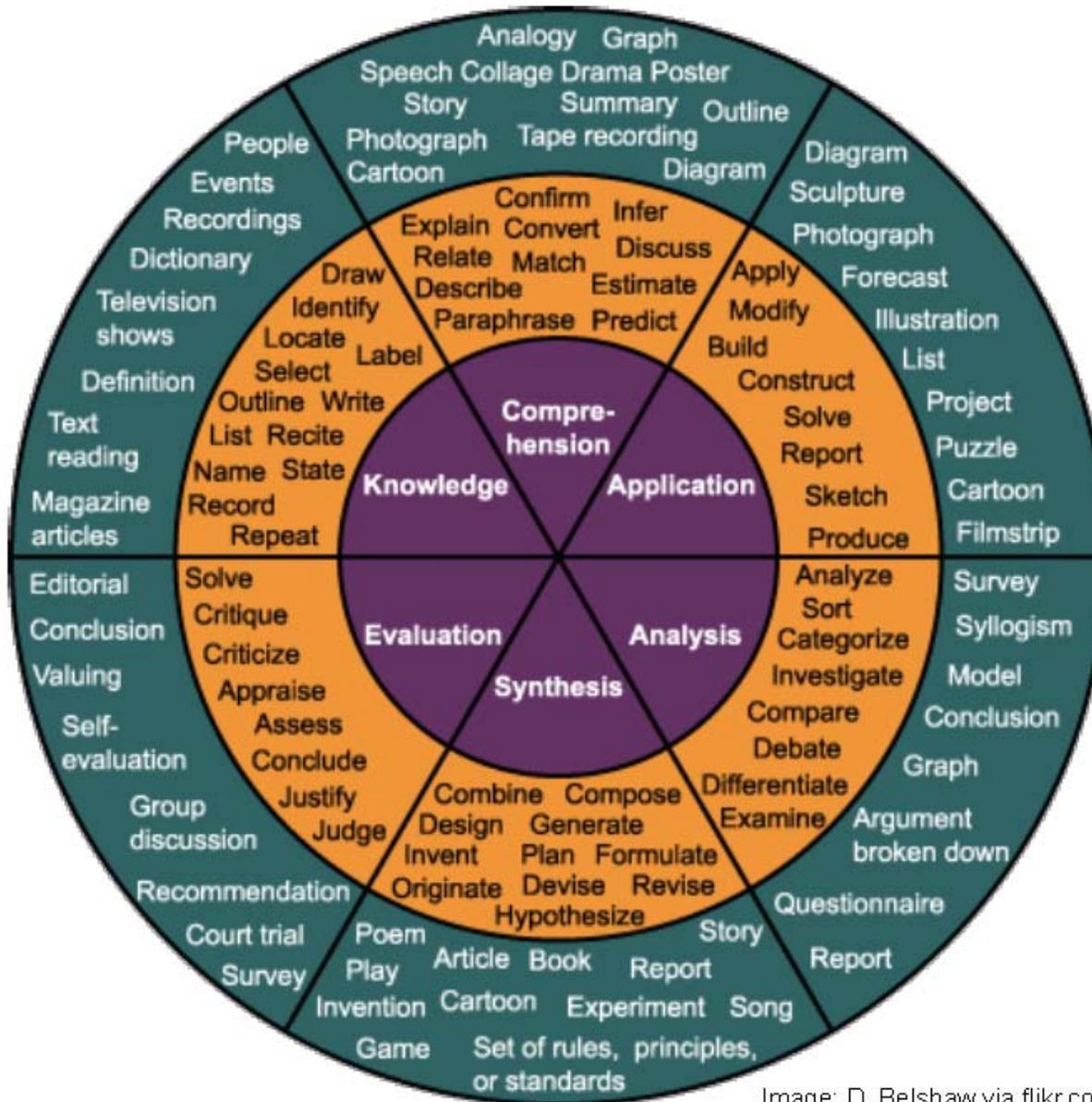
Image: D. Belshaw via flikr.com

Handout

Mock Test Blueprint

Tips for Construction

Two concerns:

    Content domain

    Cognitive level

Classify each
    objective

Decide coverage

	KNOWLEDGE	COMPREHENSION	APPLICATION	Total	%
Obj 1	1				
Obj 2			2		
Obj 3		4			
Obj 4			2		
Obj 5		1			
Total					
%					

Mock Test Blueprint

Tips for Construction

Two concerns:

    Content domain

    Cognitive level

Classify each
    objective

Decide coverage

Evaluate coverage

Adjust!

	KNOWLEDGE	COMPREHENSION	APPLICATION	Total	%
Obj 1	1			1	**10**
Obj 2			2	2	**20**
Obj 3		4		4	**40**
Obj 4			2	2	**20**
Obj 5		1		1	**10**
Total	1	5	4	10	
%	**10**	**50**	**40**		

Foundational Skill: Literature Comprehension

Learning Objectives

students should be able read a paper and :

Identify the overall context of the paper
Identify work by others critical to the paper including essential background references
Summarize the Big Picture aspect of the work
Identify the central hypothesis that is to be tested
Identify preparative experiments
Identify the critical experiments that test the hypothesis
Distinguish major conclusions reached and identify the evidence they are based upon
Discuss the reproducibility of data and how this might affect the conclusions reached.
Identify the controls that are used for major experiments
Relate the major conclusions of the paper to the big picture/context of the paper

Given:
A suitable paper from one of the leading journals in the Molecular Life Sciences

Performance
Students should be successful on 80% of the learning objectives

Example:

Foundational Skills: Experimental Design and Hypothesis Development

Learning Objectives
Students should be able to develop an experimental design outline to test the validity of this statement that demonstrates that the student:

Experimental Design
1. Recognizes that an experiment can be done to test the claim
2. Identifies what variable is manipulated (independent variable is ginseng vs. something else)
3. Identifies what variable is measured (dependent variable is endurance vs. something else)
4. Can describe how dependent variable is measured (e.g., how far subjects run will be measure of endurance
5. Has an understanding of the placebo effect
6. Realizes that there is one other variable that must be held constant (vs. no mention).
7. Realizes that there are many variables that must be held constant (vs. only one)
8. Understands that the larger the sample size or # of subjects, the better the data
9. Understands that the experiment needs to be repeated
10. Has an awareness that one can never prove a hypothesis.

Hypothesis Development
11. Develop a hypothesis regarding the mechanism of the effect

Given:
An overall scientific claim

Performance:
1. Identify aspects of experimental design (80%)
2. Develop a reasonable hypothesis concerning mechanism (100%)

Example (Taken from Sirum, K)
Advertisements for an herbal product, ginseng, claim that it promotes endurance. Develop an experimental protocol to assess the validity of this statement. Propose a hypothesis about the molecular mechanism of the effect.

Foundational skills: molarity, dilutions, amount vs concentration, pH and buffering

Learning objectives:

1. distinguish strong vs weak acid; strong vs weak base
2. understand the concept of buffering
3. understand the concept of pH
4. understand the concept of conjugate acid/ conjugate base
5. recognize the impact of concentration on buffering capacity

Given:
a list of buffers and their pKa,
the optimal pH range of an enzyme that generates or consumes H^+ ions
the pH of a solution when buffer is initially dissolved in water

Performance:
1. **Match** the reaction to an appropriate buffer (100%)
2. **Identify** the weak base/ acid in that buffer (100%)
3. **Identify** the conjugate base/ acid in that buffer (100%)
4. **Calculate** the concentration of buffer necessary to maintain the optimal pH range (75%)
5. **Devise** the appropriate strategy for adjusting a solution of buffer to the optimal pH range (100%)
6. **Compare** the buffering capacities of two buffers, with different pKa, at different concentrations (75%)

Example:
Given the optimal pH range of a reaction that generates H+ ions and a list of buffers and their pKa and pH upon dissolution in water, the student will be able to (a) **match** the reaction to the most appropriate buffer, (b) **identify** the weak base/ acid and conjugate base/ acid in the buffer, (c) **calculate** the minimum concentration of buffer required to maintain the optimal pH, (d) **formulate** a strategy for adjusting a solution of buffer to the optimal pH, and (e) **compare** the buffering capacity of the buffer at fixed concentration to that of a weaker buffer at higher concentration.

The Experimental Design Ability Test (EDAT): An Assessment Strategy to Probe Critical Thinking

- *ACUBE 2008, Hopkinsville, KY*
- *ASSESSMENT IN THE BIOLOGY CLASSROOM: HOW DO WE EVALUATE STUDENT LEARNING?*

- **Karen Sirum, PhD**
- **Assoc. Professor, Biology Education R & D**
- **Dept. of Biological Sciences**
- **Bowling Green State University, Ohio**

Pre and Post EDAT

- Advertisements for an herbal product, ginseng, claim that it promotes endurance. To determine if the claim is fraudulent and prior to accepting this claim, what type of evidence would you like to see? Provide details of an investigative design.

- The claim has been made that women may be able to achieve significant improvements in memory by taking iron supplements. To determine if the claim is fraudulent and prior to accepting this claim, what type of evidence would you like to see? Provide details of an investigative design.

Experimental Design Ability Test (EDAT) Scoring Rubric

- In response to the problem posed in the prompt, the student demonstrates:

- _____ 1. Recognition that an experiment can be done to test the claim (*vs.* simply reading the product label).

- _____ 2. Identification of what variable is manipulated (independent variable is ginseng *vs.* something else).

- _____ 3. Identification of what variable is measured (dependent variable is endurance *vs.* something else).

- _____ 4. Description of how dependent variable is measured (*e.g.,* how far subjects run will be measure of endurance).

- _____ 5. Understanding of the placebo effect (subjects do not know if they were given ginseng or a sugar pill).

- _____ 6. Realization that there is <u>one other</u> variable that must be held constant (*vs.* no mention).

- _____ 7. Realization that there are <u>many</u> variables that must be held constant (*vs.* only one or no mention).

- _____ 8. Understanding that the larger the sample size or # of subjects, the better the data.

- _____ 9. Understanding that the experiment needs to be repeated.

- _____ 10. Awareness that one can never <u>prove</u> a hypothesis, that one can never be 100% sure, that there might be another experiment that could be done that would disprove the hypothesis, that there are possible sources of error, that there are limits to generalizing the conclusions (credit for any of these).

Pre-test average score : 4.2 +/- 0.8
Post-test average score: 8.8+/- 1.3
Sample size- 79 students
The Control Group: Upper Class students in BMB Program who did not take the course: Anecdotal - comments from other faculty